

## CLAIMS

1. A magnetic sensor including a ferromagnetic tunnel junction, comprising:

a free layer a magnetic direction of which freely rotates; and

a barrier layer formed on the free layer and having a smaller thickness in a first region,

a region of the free layer corresponding to the first region functioning as a sensor portion for sensing an external magnetic field.

2. A magnetic sensor according to claim 1, wherein the barrier layer is formed by oxidizing the surface of a metal.

3. A magnetic sensor according to claim 1 or 2, further comprising:

a fixed layer formed on the barrier layer; and

a antiferromagnetic layer formed on the fixed layer and fixing a magnetic direction of the fixed layer.

4. A magnetic sensor according to claim 3, wherein the free layer in a region where the fixed layer is not formed is bent away from the fixed layer.

5. A magnetic head comprising the magnetic sensor according to any one of claims 1 to 4.

6. A magnetic encoder comprising the magnetic sensor according to any one of claims 1 to 4.

*Sub B3 C1*

7. A magnetic head comprising a ferromagnetic tunnel junction element including a free layer a magnetic direction of which freely rotates, and a fixed layer which is opposed to one surface of the free layer through a barrier layer and a magnetic direction of which is fixed by an antiferromagnetic layer which is adjacent thereto,

the free layer being connected to a member of high permeability.

8. A magnetic head according to claim 7, wherein the free layer is connected to the member of high permeability in a region spaced from a signal detection surface.

9. A magnetic head according to claim 7 or 8, wherein

the free layer is connected smoothly to the member of high permeability, neighboring the same.

10. A magnetic head according to any one of claims 7 to 9, wherein

*Sub B3 C1*

the member of high permeability is a shield layer formed, spaced from the ferromagnetic tunnel junction element.

11. A magnetic head according to any one of claim 7 to 10, wherein

a thickness of the barrier layer near the edge of the fixed layer is larger than a thickness of the barrier layer near a central part of the fixed layer.

12. A magnetic head according to any one of claims 7 to 11, wherein

the free layer is formed wider in a region spaced from the signal detection surface.

13. A magnetic head according to any one of claims 7 to 12, wherein

the fixed layer is not exposed to the signal detection surface.

14. A magnetic head according to any one of claims 7 to 13, wherein

the member of high permeability is grounded.

15. A magnetic head according to any one of claims 7 to 14, wherein

the free layer in a region which is not opposed to the fixed layer is bent away from the fixed layer.

16. A magnetic head according to any one of claims 7 to 15, wherein

the ferromagnetic tunnel junction element further includes another fixed layer which is opposed to the free layer through another barrier layer formed on the other surface of the free layer, a magnetic direction of said another fixed layer being fixed by another antiferromagnetic layer which is adjacent thereto.

17. A hard disk device comprising the magnetic head according to any one of claim 5 and claims 7 to 16.

18. A disk array device comprising a plurality of the

hard disk devices according to claim 17.